BRITISH LOWER GREENSAND SERPULIDAE

by S. WARE

ABSTRACT. The Lower Greensand serpulids of southern England are revised and the faunas from Faringdon, Oxfordshire, Upware, Cambridgeshire, Brickhill, Buckinghamshire, the Wealden region, and the Isle of Wight are compared. A new genus, *Propomatoceros*, is proposed for Cretaceous tubes hitherto assigned to *Pomatoceros* Philippi and the following new species are described: *Propomatoceros sulcicarinata*, *P. keepingi*, *P. gracilis*, *P. dentata*, *Mucroserpula nitida*, *Proliserpula faringdonensis*, *Flucticularia sharpei*, *Parsimonia upwarensis*, and *Genicularia* (*Glandifera*) *inornata*. The classification of the Serpulidae is discussed.

IN 1829 J. de C. Sowerby described and figured two serpulid species in his *Mineral Conchology of Great Britain*, *Vermetus polygonalis* from the Lower Greensand of Seabrooke, Kent, and *Serpula articulata* from Folkestone, Kent, in beds recorded as Upper Greensand but which are now regarded as Lower Greensand. Since then very little attention has been given to the serpulid fauna occurring in the Lower Greensand deposits of this country and only a few workers appear to have considered the tubes important enough to collect. Keeping (1883) figured four specimens from the Lower Greensand at Upware, Cambridgeshire, and Brickhill, Buckinghamshire, and recorded a total of ten species. Sharpe (1854) recorded four species from the Sponge Gravel at Faringdon, Oxfordshire, and Price (1874), Topley (1875), and Gregory (1895) published lists of serpulids from the Hythe and Sandgate Beds of Kent and Sussex. In Casey (1961) the recorded fauna is listed with the zonal range of each species.

The present study based mainly on the collection at the British Museum (Natural History) and the Keeping Collection housed at the Sedgwick Museum, Cambridge, has shown that the Sponge Gravel at Faringdon contains a much larger serpulid fauna than that listed by Sharpe. The purpose of this paper is to describe this fauna and revise the records from the other areas which include species ranging from the Jurassic to the Upper Chalk.

STRATIGRAPHY

The main outcrops of Lower Greensand deposits are situated in the south-east of England and the Isle of Wight. Elsewhere they occur in a series of outcrops extending from Dilton in Wiltshire north-eastwards to Lincolnshire. In the south-east region serpulids are recorded from the Hythe Beds at several localities but chiefly in the region of Hythe, the Sandgate Beds at Folkestone and Parham, near Arundel, Sussex, the Folkestone Beds at Folkestone, Kent, and the Bargate Beds in the region of Guildford and Godalming, Surrey. In the Isle of Wight they are quite common in fossiliferous horizons of the Atherfield Clay and the Ferruginous Sands. Much of the material examined from the Wealden localities and the Isle of Wight is poorly preserved. In comparison the better preservation of the tubes obtained from the Sponge

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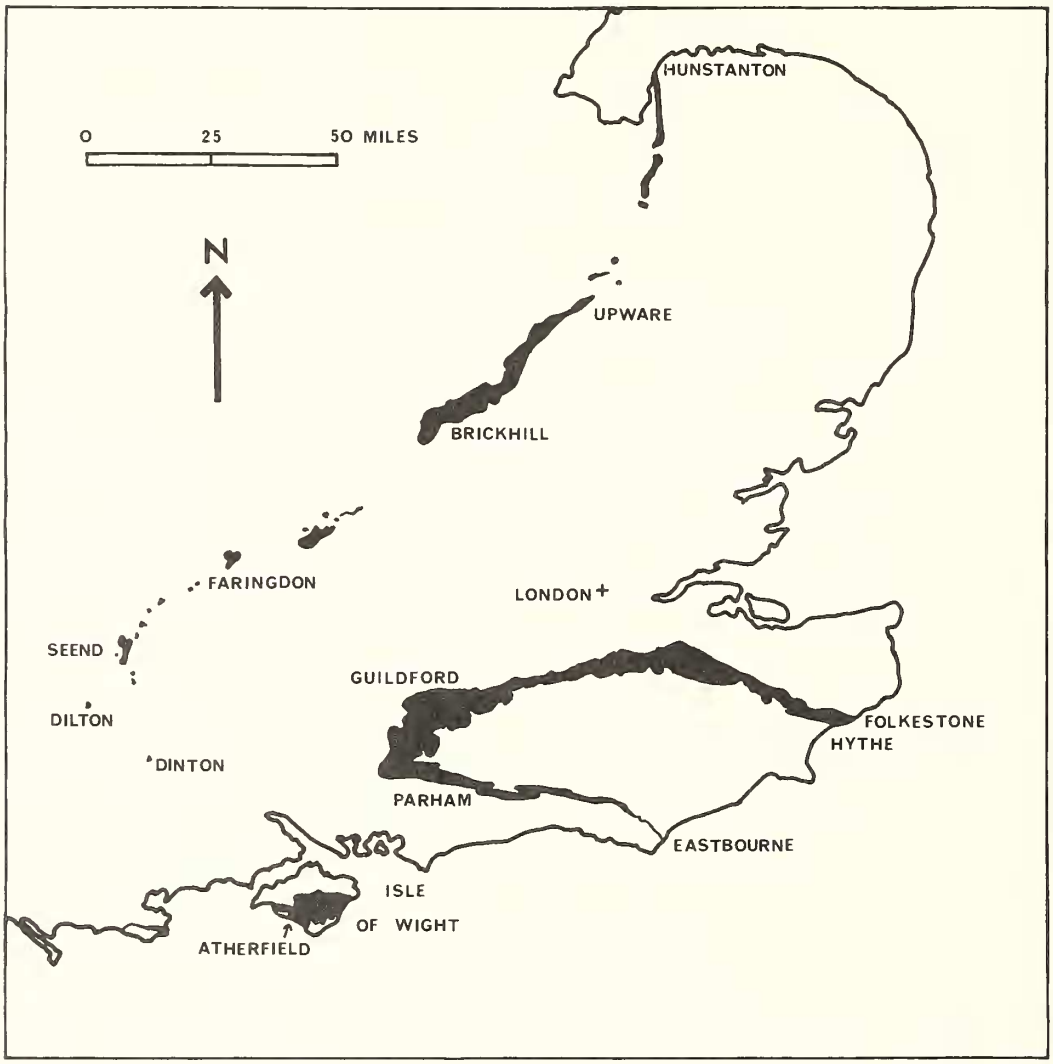
Gravels at Faringdon and the Lower Greensand at Brickhill and Upware may be attributed partly to the protected anchorages provided on the inner walls of large Calcareous sponges abundant at these localities.

A detailed account of Lower Greensand stratigraphy is given by Casey (1961) from whom the distribution map (text-fig. 1) is reproduced.



TEXT-FIG. 1. Distribution of the Lower Greensand.

THE FARINGDON SPONGE GRAVEL FAUNA

Despite the considerable interest the fossils of the Faringdon Sponge Gravel have attracted during the last century or so, only four serpulid species have been recorded from it. Sharpe (1854) noted the abundance of 'serpulae' and listed *Serpula gordialis*

(Schlotheim), *S. plexus* Sowerby, *S. obtusa* Sowerby, and *S. quinquangulata* Roemer (1840) and Keeping (1883) recorded only *S. gordialis* (Schlotheim). *S. obtusa* Sowerby and *S. plexus* Sowerby (non *S. filiformis* Sowerby) are Chalk species reflecting Sharpe's opinion that the Gravel was Upper Cretaceous in age. *S. gordialis* (Schlotheim) ranges throughout the Mesozoic leaving *S. quinquangulata* Roemer the only species limited to the Lower Cretaceous.

The present study has shown *Glomerula gordialis* (Schlotheim) to be very abundant in the Faringdon Sponge Gravel and variable in tube size from the delicate, coiled, attached section to the dense contorted masses of free tube. It is probable that the specimens recorded by Sharpe as *Serpula plexus* Sowerby belong to *G. gordialis* (Schlotheim). The five-sided tubes similar to *S. quinquangulata* Roemer have been placed in two species of *Mucroserpula* Regenhardt and the triangular carinate tubes assigned to a new genus, *Propomatoceros*.

The revised fauna is as follows:

Glomerula gordialis (Schlotheim)
Mucroserpula sp. cf. *mucroserpula* Regenhardt
Mucroserpula nitida sp. nov.
Propomatoceros sulcicarinata gen. et sp. nov.
Propomatoceros keepingi sp. nov.
Propomatoceros gracilis sp. nov.
Flucticularia sharpei sp. nov.
Proliserpula faringdonensis sp. nov.
Genicularia (*Glandifera*) *inornata* sp. nov.

The vast majority of serpulid tubes from this locality have been found encrusting the calcareous sponge, *Raphidonema*, and only rarely attached to bivalves, brachiopods, and bryozoan colonies. Moreover, they are most frequently attached to the inner walls of the sponge where protection from a turbulent environment would be greater. The external ornament of tubes situated deep inside the sponge cup is generally well preserved, whereas in those nearer the rim the ornament is more often blurred or completely eroded. With the exception of *Glomerula gordialis* and *Genicularia* (*Glandifera*) *inornata*, all of the species listed above are attached by a strong basal layer for the greater part of their length. Many of the tubes are pitted with small perforations made by an unknown organism (Pl. 19, figs. 2, 6–7; Pl. 20, figs. 2–3).

The predominance of firmly attached tubes, their location on the inner walls of sponges, and variable preservation suggests that conditions were too turbulent for species with a weak initial attachment to obtain an anchorage or these were later broken off and swept away. This may explain the presence of numerous detached masses of *Glomerula gordialis* (Schlotheim) and the apparent absence of *Rotularia* in the Sponge Gravel. The environmental conditions indicated by the serpulids is consistent with those envisaged by Elliott (1947) of shallow, rapidly moving waters in an irregularity of the sea floor, though the fossil bed itself is a current-bedded deposit of moved materials (Arkell 1947; Elliott 1956).

A single specimen of *Glomerula gordialis* (Schlotheim), BMNH. A. 10287, is attached to a worn plesiosaur vertebra probably derived from the Jurassic strata underlying the Sponge Gravel.

THE LOWER GREENSAND FAUNA AT UPWARE AND BRICKHILL

The ten species listed by Keeping (1883) are the only serpulids recorded from the Lower Greensand at Upware, Cambridgeshire, and Brickhill, Buckinghamshire. Examination of the Keeping Collection comprising sixty-one specimens (SM. B. 25951–B. 26010) loaned to me through the kindness of Dr. R. B. Rickards of the Sedgwick Museum, Cambridge, together with the collection at the British Museum (Natural History) has revealed the need for a complete revision of the existing record from these deposits.

The large tube referred by Keeping to *Serpula lophioda* Goldfuss, an Upper Cretaceous species, has been redescribed under *Propomatoceros dentata* gen. et sp. nov., and those referred to *Serpula rustica* Sowerby under *Parsimonia upwarensis* sp. nov. Some tubes identified as *Serpula antiquata* Sowerby and one as *S. ampullacea* Sowerby are also included in that species. Several identifiable specimens recorded as *S. ampullacea* have been referred to *Mucroserpula* cf. *mucroserpula* Regenhardt. The tube fragment described by Keeping as *Serpula* sp.? is too poorly preserved for generic determination and of eight other tubes so labelled in his collection, two belong to *Mucroserpula* and the remainder are indeterminate.

The revised fauna is as follows:

Propomatoceros dentata gen. et sp. nov.
Mucroserpula sp. cf. *mucroserpula* Regenhardt
Parsimonia upwarensis sp. nov.
Glomerula gordialis (Schlotheim)
Sarcinella plexus (Sowerby)
Genicularia (*Glandifera*) *articulata* (Sowerby)
Rotularia phillipsii (Roemer)
Rotularia polygonalis (Sowerby)

A single tube bearing no resemblance to the indigenous species is comparable with *Serpula sulcata* Sowerby and probably derived from the Upper Jurassic (Pl. 20, fig. 7).

The serpulid fauna of the Lower Greensand at these localities (mainly Upware) has much in common with that of the Sponge Gravel at Faringdon, the most significant difference being the occurrence of *Rotularia* spp. not yet found at Faringdon. *Parsimonia upwarensis* sp. nov. which develops large free sections of tube at Upware is also unrepresented at Faringdon but it occurs in the Bargate Stone of the Guildford region, the tubes being much smaller. Apart from these indications of less-turbulent conditions than those envisaged for the Faringdon serpulids, a much larger percentage of tubes are attached to phosphatic nodules compared with only six specimens encrusting Calcareous sponges. There was no lack of sponges at Upware for providing a protected anchorage; as Keeping (1883, p. 28) commented, sponges were 'nobly represented' and 'Beautiful cup sponges' flourished around the Upware Coral Bank.

It is unfortunate that the volume of material collected from these deposits is so limited and that most of it is so eroded that the external ornament is often barely discernible.

THE FAUNA OF THE WEALDEN REGION AND THE ISLE OF WIGHT

Casey (1961) listed eight species from the Lower Greensand and gave their zonal ranges: *Serpula antiquata* Sowerby, *S. filiformis* Sowerby, *S. articulata* Sowerby, *S. plexus* Sowerby, *S.* cf. *adnata* Wade, *S. gordialis* (Schlotheim), *Rotularia polygonalis* Sowerby, and *R. concava* Sowerby. With the exception of *S. filiformis* [=*Sarcinella plexus* (Sowerby)] and *S.* cf. *adnata* Wade which appears to be the attached portion of *Glomerula gordialis* (Schlotheim), all of the species in this list occur in the deposits of this region. Previous records by Sowerby (1829), Price (1874), and Topley (1875) show that most of the species recorded from this region were obtained from the Hythe Beds at localities in the vicinity of Hythe and the Folkestone Beds at Folkestone, Kent. From the western part of the region, Keeping (1883) recorded *Serpula rustica* Sowerby in the Lower Greensand of Godalming, Surrey, and Topley (1875) listed *Serpula*? sp. from the Bargate Stone at the same locality.

In the collections at the British Museum (Natural History) a sample comprising thirty-one specimens from the Bargate Stone at Littleton and Shackleford, SW. of Guildford, Surrey has yielded four species:

Parsimonia upwarensis sp. nov.
Flucticularia sharpei sp. nov.
Sarcinella plexus (Sowerby)
Rotularia polygonalis (Sowerby)

It is probable that the tubes from Godalming recorded by Keeping as *Serpula rustica* Sowerby were obtained from the Bargate Stone and may be referred to *Parsimonia upwarensis*. Most of the tubes from this horizon are quite well preserved and, excluding the *Rotularia* specimens, they are attached to phosphatic nodules.

The list of species is revised as follows:

Parsimonia antiquata (Sowerby)
Parsimonia upwarensis sp. nov.
Flucticularia sharpei sp. nov.
Glomerula gordialis (Schlotheim)
Sarcinella plexus (Sowerby)
Genicularia (*Glandifera*) *articulata* (Sowerby)
Rotularia concava (Sowerby)
Rotularia polygonalis (Sowerby)

In contrast with the serpulid fauna of the Faringdon Sponge Gravel and to a lesser extent the Lower Greensand at Upware and Brickhill where most of the species have a firm basal attachment, the species which predominate in the Hythe and Folkestone Beds have a weak initial attachment, *Parsimonia antiquata* (Sowerby) being the only firmly fixed species. The restricted fauna of the Bargate Stone includes *Flucticularia sharpei* and *Parsimonia upwarensis* in common with the beds at Faringdon and Upware, and although *Sarcinella plexus* and *Rotularia polygonalis* are recorded from Upware, they are more abundant and representative of the Hythe Beds of this region.

In the Lower Greensand deposits of the Isle of Wight, the serpulid fauna comprising four species is typical of the Wealden region.

Parsimonia antiquata (J. de C. Sowerby)
Glomerula gordialis (Schlotheim)
Sarcinella plexus (J. de C. Sowerby)
Rotularia polygonalis (J. de C. Sowerby)

Whereas *Parsimonia antiquata* (J. de C. Sowerby) occurs only in the *Perna* Bed of the Atherfield Clay, the other species listed are quite common in that bed and also occur in the Crackers near the base of the Ferruginous Sands.

CLASSIFICATION

In the works of Parsch (1956), Regenhardt (1961, 1964), and Schmidt (1955, 1969) distinct classifications with some overlapping have been erected for Jurassic, Cretaceous, and Tertiary serpulid tubes respectively. Parsch classified the Jurassic serpulids of south-west Germany and established species described by Goldfuss, Quenstedt, and others by arranging them within five sub-genera of *Serpula*, each sub-genus being indicated by a prefix (e.g. *Dorsoserpula*). In this respect, and also in being based entirely on tube morphology, his classification is comparable with that proposed by Nielsen (1931) for the Senonian and Danian serpulids of Denmark in which *Ditrupa* was modified to *Ditrupula* and *Serpula* to *Serpentula* to produce a separate parallel classification for the fossil tubes. In the classification adopted by Regenhardt for the Chalk serpulids of Mid-Europe the generic characters are based on the cross-section of the tube and changes in its development, while differences in external ornamentation were the main specific criteria. It comprises thirty-two genera, fourteen of which are new, supercedes almost entirely the work of Nielsen and by including many Jurassic species within its scope it overlaps the classification erected by Parsch. Except for several fossil genera ranging from the Cretaceous to the Eocene, Schmidt has used Recent genera in his classification of Tertiary serpulid tubes.

The existence of separate classifications for Jurassic, Cretaceous, and Tertiary serpulid tubes is unsatisfactory and as Bignot (1968) remarked 'a synthesized complete regrouping of Jurassic, Cretaceous, Tertiary and Recent tubes is desirable'. A revision such as this would possibly help to resolve the problem whether Recent serpulids, where the tube is of minor importance in identification, should be classified separately from fossil tubes. At present a study of the microstructure of the tubes of fossil and Recent genera under the Scanning Electron Microscope is in progress which may provide data for a unified classification.

In this paper the classification is based mainly on the works of Regenhardt (1961, 1964). A new genus, *Propomatoceros*, is proposed for triangular Cretaceous species hitherto included in *Pomatoceros* Philippi.

SYSTEMATIC DESCRIPTIONS

Specimens prefixed A are deposited in the Palaeontology Department, British Museum (Natural History); those prefixed B in the Sedgwick Museum, Cambridge.

Phylum ANNELIDA Lamarck
Class POLYCHAETA Grube, 1850
Family SERPULIDAE Burmeister, 1837
Subfamily SERPULINAE Rioja, 1925
Genus PROPOMATOCEROS nov.

Type species. Propomatoceros sulcicarinata sp. nov.

Derivation of name. Pro—in place of—*Pomatoceros.*

Diagnosis. Serpulinae having a carinate tube, initially triangular, becoming increasingly convex to sub-cylindrical in cross-section. Completely attached or with a free cylindrical anterior segment. Lateral surfaces have fine growth lines arched forward from the basal layer of attachment to the dorsal carina which forms a tooth-like projection over the aperture.

Remarks. Propomatoceros is proposed for Cretaceous serpulid tubes which resemble *Pomatoceros* Philippi in the initial triangular growth stage (Pl. 18, figs. 3–4) but differ in having a further convex and sometimes a free cylindrical stage of variable length (Pl. 18, figs. 1–2, 10).

Regenhardt (1961) erected a new tribe, Mucroserpulae for angular serpulids, placing 4–5 sided tubes in *Mucroserpula* and triangular tubes in *Pomatoceros.* He assigned five Cretaceous species to the genus and extended its range to 'Jurassic, Zechstein'. These Cretaceous species, together with the miscellaneous triangular tubes in the Jurassic, introduce a range of variation too great for their inclusion in *Pomatoceros*; the Cretaceous species are accordingly placed in *Propomatoceros.* They include *Serpula lophioda* Goldfuss and *S. trachinus* Goldfuss from the Cenomanian of Germany, *S. triangularis* Goldfuss (Santonian–Maestrichtian) and *S. biplicatus* Reuss (Turonian) of Germany, and *P. semicostatus* Regenhardt from the Barremian of Hildesheim. In *S. lophioda* the anterior part of the tube becomes strongly rounded and in *S. trachinus* the anterior convexity is even greater. The holotype of *P. semicostatus* loaned to me through the generous assistance of Dr. Hans Lafrenz of the Geologisches-Palaontologisches Institut, Hamburg, is a slender tube comparable in size and external ornament with *Propomatoceros gracilis* sp. nov. from the Faringdon Sponge Gravel. *S. triangularis* and *S. biplicatus* like *S. avita* J. de C. Sowerby from the Turonian of England are triangular throughout their length and lacking evidence of further development, they can only be included tentatively.

Propomatoceros sulcicarinata sp. nov.

Plate 18, figs. 1–4

Holotype. A. 1037.

Paratypes. A. 10233, A. 10297, A. 10812.

Distribution. Yellow Sponge Gravel (Aptian, Nutfieldiensis Zone), Faringdon, Oxfordshire.

Diagnosis. A species with a strong square dorsal carina which becomes furrowed in the later stage of growth.

Description. The tube is attached for most of its length and may vary in development from a tight coil to almost straight. Those forming a tight initial coil may be sinuous or curved thereafter. In the early stage of development (Pl. 18, figs. 3–4) the tube has a triangular cross-section which becomes more and more convex as it increases in size and in the final stage it is cylindrical in outline with longitudinal sulci at the junction of the walls and the expanded base. The thick dorsal carina is more or less square and continuous in the early triangular part; in the convex stage it becomes furrowed. This is generally shallow but may be deep enough to produce two parallel carinae before passing to the coarse cylindrical stage where it is rather obscure and irregular. The lateral surfaces have growth lines reflected forward in an arc so that they meet at the dorsal carina. The tooth-like projection formed by the carina over the aperture is very clear in the triangular stage but much less so where the carina is furrowed or obscure.

Remarks. P. sulcicarinata can be distinguished from all of the other species by its large partially furrowed dorsal carina. *P. keepingi* sp. nov. is closest to it but has a blade-like carina.

In the Sponge Gravel at Faringdon this species has been found only on the inner wall of *Raphidonema* spp.

Propomatoceros keepingi sp. nov.

Plate 18, figs. 5–6

Holotype. A. 10229.

Paratype. A. 10765.

Derivation of name. After W. Keeping.

Distribution. Yellow Sponge Gravel (Aptian, Nutfieldiensis Zone), Faringdon, Oxfordshire.

Diagnosis. A smooth, thin-shelled species with a strong blade-like dorsal carina and convex lateral walls.

Description. The tube is almost completely attached and may be coiled back on to itself or sinuous. On the convex lateral walls a weak ridge extends along the tube approximately midway between the base and the dorsal carina and vertical growth

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EXPLANATION OF PLATE 18

Figs. 1–8. Sponge Gravel (Aptian, Nutfieldiensis Zone), Faringdon, Oxfordshire. 1–4, *Propomatoceros sulcicarinata* gen. et sp. nov. 1, holotype, A. 1037, ×2; 2, paratype, A. 10233, ×2; 3–4, initial growth stage; 3, dorsal view, A. 10297, 4, view of aperture, A. 10812, both ×5. 5–6, *Propomatoceros keepingi* sp. nov. 5, holotype, A. 10229, ×2; 6, paratype, A. 10765, ×2. 7–8, *Propomatoceros gracilis* sp. nov. 7, holotype, A. 10814, ×3; 8, view of arched ribs, A. 10813, ×5.

Figs. 9–10. *Propomatoceros dentata* sp. nov. Two adjacent tubes on *Raphidonema* sp. Lower Greensand (Aptian), Upware, Cambridgeshire. 9, holotype, B. 25951a, ×2; 10, tube figured by Keeping, pl. 7, fig. 5, as *Serpula lophioda* Goldfuss, B. 25951b, ×1.

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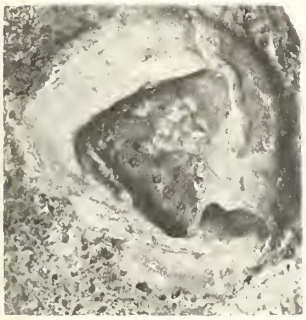

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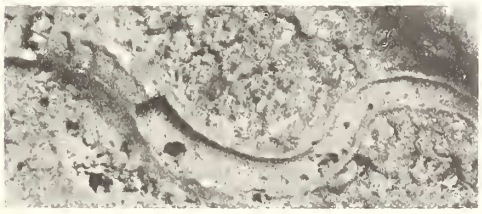

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lines from the base to the ridge arch forward into the carina. In the holotype a transverse swelling marks a pause in growth and a second rib-like swelling marks the beginning of the enlarged anterior tube segment. A prominent blade-like dorsal carina extends unbroken to within 4 mm of the aperture, at which point the tube increases in size and convexity and the carina is less prominent. The aperture is large, sub-cylindrical in outline, and notched at the apex of the tube. The tube is smooth and has very thin lateral walls.

Remarks. *P. lophioda* (Goldfuss) and *P. trachinus* (Goldfuss) are comparable in the convexity of their cross-section with this species but in the former the carina is much thinner and in the latter it is plicate and gives way to a furrow in the anterior part of the tube. The upper Cretaceous species, *P. avita* (J. de C. Sowerby) and *P. triangularis* (Goldfuss) have sharper carinae and a less convex cross-section.

Propomatoceros gracilis sp. nov.

Plate 18, figs. 7–8

Holotype. A. 10814.

Paratypes. A. 10768–10769, A. 10813.

Distribution. Red Sponge Gravel (Aptian, Nutfieldiensis Zone), Faringdon, Oxfordshire.

Diagnosis. A slender, convexly triangular tube with finely striated lateral walls ribbed at intervals and a thin dorsal carina.

Description. The tube is straight or slightly curved, slender with an almost imperceptible increase in size. It increases in convexity gradually from a rather triangular beginning. A thin dorsal carina is continuous along the tube and the lateral walls are marked by fine striae which arch forward from the base to the carina. At intervals these striae may be replaced by ribs similarly arched (Pl. 18, fig. 8). The specimens figured here are incomplete and details of the aperture cannot be given. In A. 10768, a specimen donated recently to the British Museum (Natural History) Collection, the beginning of a cylindrical, possibly free stage of development can be seen.

Remarks. This small slender species is easily distinguishable from all except *P. semicostatus* Regenhardt from the Barremian of Hildesheim, Germany, which resembles it very closely. It is equally slender but rather more triangular initially than *P. gracilis* and the transverse ribbing is confined to the upper part of the lateral walls.

Propomatoceros dentata sp. nov.

Plate 18, figs. 9–10

1883 *Serpula lophioda* Goldfuss; Keeping, p. 131, pl. 7, fig. 5*a*–*b*.

Holotype. B. 25951*a*.

Paratype. B. 25951*b*.

Distribution. Lower Greensand (Lower Aptian), Upware, Cambridgeshire.

Diagnosis. A species with a dentate dorsal carina.

Description. This species is represented by two adjacent tubes attached to the inner

wall of a Calcareous sponge, *Raphidonema porcatum* Hinde. The holotype (Pl. 18, fig. 9) is approximately 5 cm long, sinuous, obtusely triangular in cross-section, and attached by a slightly expanded base. A notched, plicate, fin-shaped dorsal carina extends along the tube which lacks the anterior terminal section. The sides are ornamented by transverse striae and at irregular intervals, swellings which bend forward to meet in dentate projections at the carina mark a series of growth pauses. The paratype (Pl. 18, fig. 10) figured by Keeping (see synonymy) is curved, approximately 13 cm in length, obtusely triangular for the first 6 cm and thereafter becomes increasingly convex. In the early part of this tube the dorsal carina is less prominent than in the holotype and becomes both irregular and progressively weaker in the more convex later stage of development.

Remarks. The strong dentate carina distinguishes this species from *P. lophioda* (Goldfuss) and in *P. trachinus* (Goldfuss) which is closest to it, the plicate carina gives way to a furrow in the anterior part of the tube.

Genus MUCROSERPULA Regenhardt, 1961

Mucroserpula nitida sp. nov.

Plate 19, figs. 1–2

Holotype. A. 5669.

Paratype. A. 10772.

Distribution. Yellow Sponge Gravel (Aptian, Nutfieldiensis Zone), Faringdon, Oxfordshire.

Diagnosis. A species of *Mucroserpula* with a thin, smooth, angular, non-carinate tube almost entirely attached. Free portion short and cylindrical.

Description. The tube is coiled in a circle or may form a loop, attached for most of its length and pentagonal in cross-section. In the attached stage the sides slope steeply from the base to lateral ridges and become more upright as the tube enlarges. From the lateral ridges to the median ridge the dorsal surface forms a high V-shaped arch which flattens out anteriorly. In the holotype a transverse swelling marks the beginning of the free cylindrical stage of the tube. In this stage the tube increases in size rapidly to the large, dorsally projecting aperture. The tube is very thin and smooth and lacks any external ornament, probably due to its rather weathered state.

Remarks. This species is easily distinguishable from *M. arcuata* (Munster), *M. quinquangulata* (Roemer), and *M. versabunda* Regenhardt by its lack of carinae, and it differs from *M. mucroserpula* Regenhardt in having sharper angulation, and a thin tube which is much smoother in texture.

Mucroserpula sp. cf. *mucroserpula* Regenhardt

Plate 19, figs. 3–5

cf. 1961 *Mucroserpula mucroserpula* Regenhardt, p. 47, pl. 4, fig. 2.

Material. A. 10289, A. 10256 and four other specimens (Faringdon); B. 25989 and six other specimens (Upware).

Distribution. Yellow Sponge Gravel (Aptian, Nutfieldiensis Zone), Faringdon, Oxfordshire; Lower Greensand (Lower Aptian), Upware, Cambridgeshire.

Description. These tubes may form a tight coil or a wide curve in their development and are entirely attached. Initially the cross-section of the tube is triangular with very convex sides which meet in a low dorsal ridge. With the increase in size the tube becomes quadrangular as the dorsal surface flattens out and the dorsal ridge weakens and may disappear completely. Transverse growth lines clearly visible only in the later stage of the tube arch forward on the dorsal surface to form projections along the ridge. At the aperture of A. 10289 the tube is 4 mm in width and the thickness of the tube is approximately 1 mm.

Remarks. Although no differences can be discerned between the tubes described here and *M. mucroserpula* Regenhardt from the Hauterivian deposits of Schandelah, Niedersachsen, Germany, their poor preservation does not allow more than a comparison with that species.

Genus FLUCTICULARIA Regenhardt, 1961

Flucticularia sharpei sp. nov.

Plate 20, figs. 1–4

Holotype. A. 10261.

Paratypes. A. 10305, A. 10298.

Derivation of name. The species is named in honour of Daniel Sharpe who first recorded serpulids from the Sponge Gravel at Faringdon, Oxfordshire.

Distribution. Yellow Sponge Gravel (Aptian, Nutfieldiensis Zone), Faringdon, Oxfordshire (type locality); Bargate Stone (Aptian, Nutfieldiensis Zone), Shackleford, SW. of Guildford, Surrey.

Diagnosis. An attached species with irregular transverse swellings and three plicate dorsal carinae.

Description. The tube is entirely attached and uniform in its gradual increase in size. It is pentagonal in cross-section and may be sinuous, curved, or loosely coiled in development. At irregular intervals along the tube earlier apertures are indicated by transverse swellings from the inner surfaces of which successive tube segments are secreted. The vertical or slightly diagonal side walls are capped by plicate carinae from which the dorsal surfaces slope upwards very slightly to a stronger median

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EXPLANATION OF PLATE 19

Figs. 1–2. *Mucroserpula nitida* sp. nov. Sponge Gravel (Aptian, Nutfieldiensis Zone), Faringdon, Oxfordshire. 1, holotype, A. 5669, ×5; 2, paratype, A. 10772, ×3.

Figs. 3–5. *Mucroserpula* sp. cf. *mucroserpula* Regenhardt. 3–4, Sponge Gravel (Aptian, Nutfieldiensis Zone), Faringdon, Oxfordshire. 3, A. 10289, ×5; 4, A. 10256, ×5; 5, B. 25989, ×2; Lower Greensand (Aptian), Upware, Cambridgeshire.

Figs. 6–7. *Proliserpula faringdonensis* sp. nov. Sponge Gravel (Aptian, Nutfieldiensis Zone), Faringdon, Oxfordshire. 6, holotype, A. 10766, ×5; 7, paratype, A. 10257, ×5.

Figs. 8–9. *Genicularia* (*Glandifera*) *inornata* sp. nov. Sponge Gravel (Aptian, Nutfieldiensis Zone), Faringdon, Oxfordshire. 8, holotype, A. 10222, ×5; 9, paratype, A. 8854, ×5.

Fig. 10. *Genicularia* (*Glandifera*) *articulata* (J. de C. Sowerby). B. 25967, ×5. Figured by Keeping, pl. 7, fig. 7. Lower Greensand (Aptian), Upware, Cambridgeshire.

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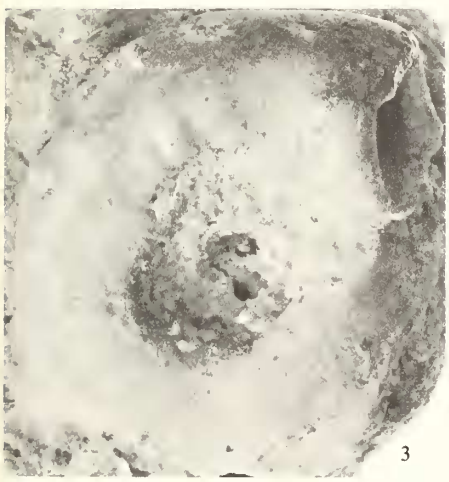

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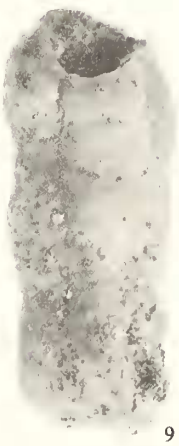

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WARE, Lower Greensand Serpulidae

plicate carina. In the holotype the lumen has a diameter of 2 mm and the carinae form lobes over the aperture.

Dimensions.

	Length	Width (at aperture)
A. 10261	40 mm	3·5 mm
A. 10305	16 mm	2·0 mm
A. 10298	14 mm	—

Remarks. Regenhardt (1961) erected *Flucticularia* for tubes with plicate carinae. Among the Upper Cretaceous species that he included in the genus, *F. fluctuata* (J. de C. Sowerby) and *F. cincta* (Goldfuss) occur in the Chalk of this country, the earliest record for each being Turonian (Rowe 1903, 1908). *F. fluctuata* (J. de C. Sowerby) is easily distinguished from *F. sharpei* by its smaller tube, its regular pentagonal cross-section, and five distinct carinae. *F. cincta* (Goldfuss) is smaller also but almost identical in cross-section. Apart from its size it differs from *F. sharpei* only in the greater thickness of the apertural swellings which occur at intervals along the tube.

Previously unrecorded tubes from the Upper Albian, Red Chalk of Hunstanton, Norfolk, are closely comparable with *F. sharpei*, differing only in a more pronounced plication of the lateral carinae. However, as this may be attributable to their better preservation, they are provisionally included in this species.

Genus PROLISERPULA Regenhardt, 1961

Proliserpula faringdonensis sp. nov.

Plate 19, figs. 6–7

Holotype. A. 10766.

Paratype. A. 10257.

Distribution. Yellow Sponge Gravel (Aptian, Nutfieldiensis Zone), Faringdon, Oxfordshire.

Diagnosis. A small sub-cylindrical species with a thick tube segmented by quadrate annular swellings.

Description. The tube is completely attached by an expanded basal layer above which it has a cylindrical cross-section. It may develop in a tight coil or loosely in the form of a loop. The dorsal surface may be rather flattened in one part and lumpy

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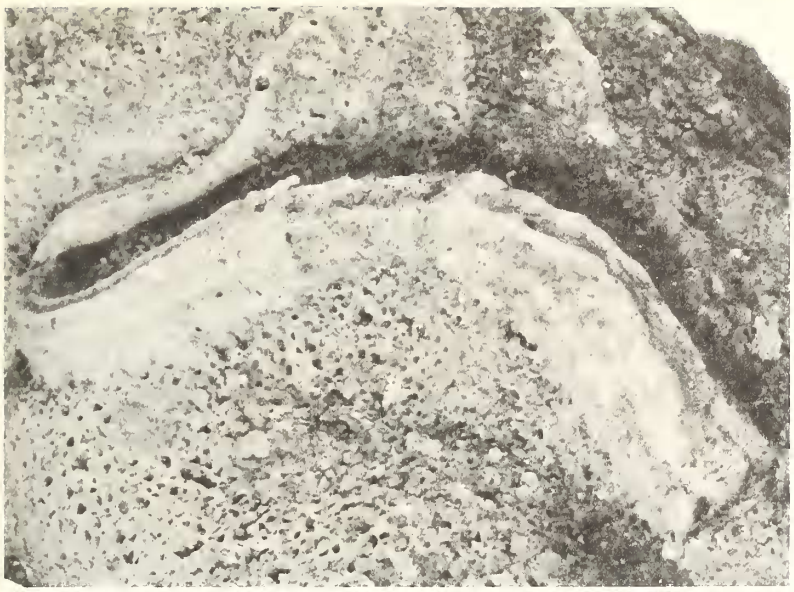
EXPLANATION OF PLATE 20

Figs. 1–4. *Flucticularia sharpei* sp. nov. 1–3, Sponge Gravel (Aptian, Nutfieldiensis Zone), Faringdon, Oxfordshire. 1, holotype, A. 10261, ×5; 2–3, paratypes, A. 10305, ×5; A. 10298, ×10; 4, Bargate Stone (Aptian, Nutfieldiensis Zone), Shackleford, SW. of Guildford, Surrey, A. 2648, ×5.

Fig. 5. *Glomerula gordialis* (Schlotheim). Sponge Gravel (Aptian, Nutfieldiensis Zone), Faringdon, Oxfordshire. Initial attached stage, A. 10300, ×10.

Fig. 6. *Sarcinella plexus* (J. de C. Sowerby). Ferruginous Sands (Aptian), Shanklin, Isle of Wight, A. 10789, ×2.

Fig. 7. *Serpula* cf. *sulcata* J. de C. Sowerby. Lower Greensand (Aptian), Upware, Cambridgeshire, B. 25973, ×2 (?derived from Jurassic).



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WARE, Lower Greensand Serpulidae

in another giving the tube an undulating appearance. Transverse striation visible only on the inner surface of the holotype has been obliterated by minute perforations and weathering on the dorsal and outer surfaces. At irregular intervals following a gradual enlargement of the tube, the outer layer thickens to form rounded quadrate swellings from which new segments are secreted. The small circular lumen is enclosed by a thick inner layer and an exceptionally thick outer layer.

Remarks. In his new genus, *Proliserpula*, Regenhardt (1961) described seven species from Upper Cretaceous and one species from Barremian deposits in Germany. He also included *Serpula ampullacea* J. de C. Sowerby and *S. obtusa* J. de C. Sowerby from the British Chalk in this genus. It has not been recorded previously from beds of Aptian age.

P. faringdonensis does not possess any marked differences from some of the coiled Upper Cretaceous species. *P. dithyrambica* Regenhardt is comparable in size, smoothness, and has similar transverse angular swellings; its faint dorsal carina being the only apparent difference. The common Chalk species, *P. ampullacea* (J. de C. Sowerby) and *P.* (*Parricidula*) *parricidula* Regenhardt (= *Serpula ampullacea* J. de C. Sowerby, 1829, pl. 597, fig. 5) are generally much larger, with globose swellings and faintly carinate on the dorsal surface. *P. obtusa* (J. de C. Sowerby), a sinuous, initially triangular species with a thick dorsal carina is not characteristic of this genus and is here considered to belong to *Propomatoceros.*

Genus PARSIMONIA Regenhardt, 1961

Parsimonia upwarensis sp. nov.

Plate 21, figs. 1–7

1883 *Serpula rustica* J. de C. Sowerby; Keeping, p. 131, pl. 7, fig. 6*a–b*.
1883 *Serpula antiquata* J. de C. Sowerby; Keeping, p. 132.

Holotype. The larger overlapping tube on B. 25952.

Additional material. B. 25953, B. 25954–24966, B. 25970–25971, B. 25974, B. 25990; A. 192, A. 10174–10178, A. 10720–10724, A. 2632–2635, A. 2656.

Distribution. Lower Greensand (Lower Aptian), Upware, Cambridgeshire (type locality), Brickhill, Buckinghamshire; Bargate Stone (Aptian, Nutfieldiensis Zone), Littleton and Shackleford, SW. of Guildford, Surrey.

EXPLANATION OF PLATE 21

Figs. 1–7. *Parsimonia upwarensis* sp. nov. 1–5, Lower Greensand (Aptian), Upware, Cambridgeshire. 1, holotype, B. 25952, ×2. Figured by Keeping, pl. 7, fig. 6*a* as *Serpula rustica* J. de C. Sowerby; 2–3, paratypes; 2, B. 25953, ×2; 3, A. 10720, ×2; 4, B. 25970, ×1. Recorded by Keeping, p. 131, as *Serpula antiquata* J. de C. Sowerby; 5, B. 25990, ×2. Recorded by Keeping as *Serpula ampullacea* J. de C. Sowerby; 6–7, Bargate Stone (Aptian, Nutfieldiensis Zone); 6, free tube fragment, Shackleford, A. 2632, ×2; 7, attached stage, Littleton, SW. of Guildford, Surrey, A. 2656, ×5.

Fig. 8. *Parsimonia antiquata* (J. de C. Sowerby), Atherfield Clay, *Perna* Bed (Aptian, Fissicostatus Zone), Atherfield, Isle of Wight, A. 197, ×2.

Figs. 9–10. *Rotularia polygonalis* (J. de C. Sowerby). 9, Ferruginous Sands Crackers (Aptian, Forbesi Zone), Atherfield, Isle of Wight, A. 10761; 10, Hythe Beds (Aptian), Maidstone, Kent, A. 1049. Both ×5.

WARE, Lower Greensand Serpulidae

Diagnosis. A species with a convex, triangular, attached tube, dorsally ridged and an obtusely four-sided free stage of growth.

Description. The tube is attached by an expanded base for a variable length before it becomes elevated and free. In the initial attached stage it may be curved or form a loop and increases gradually in size. It has a triangular cross-section which becomes increasingly convex and a weak ridge extends along the whole of this stage. The free stage of development begins on a platform formed by a thickening of the basal layer which raises the aperture and brings about an upward direction of growth. The free stage of the tube may also vary considerably in length, the longest free segment measuring 60 mm (B. 25958), but the diameter appears to remain constant regardless of the length of the tube. It is almost square in cross-section with rounded edges in well-preserved specimens but roughly cylindrical in weathered specimens. Irregular transverse folds encircle the tube and represent the contracted margins of successive apertures. The short intervening segments have nodular swellings placed unevenly at each edge which produce the obtusely square outline of the free tube in this species. Each side has a wavy median longitudinal furrow well defined in the square parts of the tube but obscure where it is more cylindrical. Transverse growth lines bend forward into the dorsal ridge in the attached stage and into each of the four median furrows in the free stage.

In the holotype the aperture is 8 mm wide with a lumen 5 mm in diameter and the tube on which it has grown has a width of 6 mm and a lumen 4 mm in diameter.

Dimensions of Holotype.

Length	Free segment
50 mm	9 mm

Remarks. Serpula rustica, to which species Keeping referred these tubes was described by J. de C. Sowerby (1829, p. 203, pl. 597, fig. 3) as follows:

> 'Tube externally four angled, angles obtuse; as the tube increases the angles are variously bent and interrupted, at length becoming irregular convexities arranged about a cylindrical tube. Nearly two lines in diameter and almost straight. The aperture is circular with a sharp edge. Found in a light-coloured marl belonging to the Upper Greensand, at East Weare Bay.'

Unfortunately, the specimen that he figured is an incomplete fragment lacking the initial stage of growth which appears to be rather poorly preserved and distorted. Regenhardt (1961) referred the species to his new sub-genus *Genicularia* (*Glandifera*). Well preserved, free, entirely quadrangular nodose tubes from the Gault Clay at Folkestone and the Cenomanian Chalk at Dover, Kent, clearly belonging to this subgenus, are comparable with *G.* (*Glandifera*) *rustica* (J. de C. Sowerby).

The tubes redescribed here resemble *G.* (*Glandifera*) *rustica* (J. de C. Sowerby) only in the quadrangular outline of the free segments; they differ from that species in their development from an attached, triangular stage to a free quadrangular stage, the transverse growth lines and folds, and the aperture which is not constricted as in species of *G.* (*Glandifera*). On the other hand, their development is characteristic of *Parsimonia* Regenhardt and for that reason they are assigned to that genus. *P. upwarensis* is distinguishable from *P. antiquata* (J. de C. Sowerby) by the more

triangular outline of the attached stage and the quadrangular free tube. Specimens recorded by Keeping as *Serpula antiquata* J. de C. Sowerby (Pl. 21, fig. 4) differ from the quadrangular tubes only in their more weathered condition which has obscured the angulation and are therefore included in this species.

Parsimonia antiquata (J. de C. Sowerby)

Plate 21, fig. 8

Material. A. 197 and five other specimens.

Distribution. Atherfield Clay, *Perna* Bed (Aptian, Fissicostatus Zone), Atherfield, Isle of Wight.

Diagnosis. Sowerby (1829): 'Cylindrical, partly attached by an expanded surface; surface uneven, with transverse irregular rings.'

Description. The attached, convexly triangular portion of the tube gradually increases in size and convexity to become cylindrical and free. Transverse growth lines on the lateral surfaces of the attached part bend forward to meet in the form of a chevron at the low dorsal ridge. On the cylindrical part of the tube the ridge is absent and the growth lines are circular and coarse, making the surface uneven.

Remarks. Parsimonia antiquata (J. de C. Sowerby) is common in the Lower Cenomanian and Upper Albian deposits of this country but few records exist of its occurrence in the Aptian. Topley (1875) recorded it from the Hythe Beds at Hythe and the Lower Greensand, Isle of Wight. The only other record I have been able to find is that of Casey (1961) where the range is given as *deshayesi* Zone–*mammillatum* Zone. Unless other records exist, it has not been recorded from the *Perna* Beds in the Atherfield Clay previously.

These tubes are referred to *P. antiquata* (J. de C. Sowerby) because they possess no significant differences from the type specimen but better preserved material might indicate the need for placing them in a new species.

Subfamily DITRUPINAE Regenhardt, 1961
Genus GENICULARIA Quenstedt, 1858
Subgenus GLANDIFERA Regenhardt, 1961
Genicularia (*Glandifera*) *inornata* sp. nov.

Plate 19, figs. 8–9

Holotype. A. 10222.

Paratypes. A. 8854, A. 10129, A. 10284.

Distribution. Yellow Sponge Gravel (Aptian, Nutfieldiensis Zone), Faringdon, Oxfordshire.

Diagnosis. A species with four rounded keels, weak obtuse swellings, and shallow median furrows on each of the four sides.

Description. The tube is free, straight or slightly curved, with four rounded keels giving it a quadrangular cross-section with rather concave sides. The keels are composed of short compact segments secreted in the form of weak obtuse swellings. In the holotype (Pl. 19, fig. 8) the swellings are so poorly developed that the keels have

a continuous undulating profile but in the somewhat larger paratype (Pl. 19, fig. 9) they are more prominent. On the lateral surfaces shallow longitudinal median furrows forming the margins of the keels are slightly deeper on three of the sides than on the other one. Very faint transverse growth lines which bend away from the aperture at each of the furrows are barely visible on the holotype but quite clearly marked on A. 10284. The aperture is circular, constricted and unbroken in the holotype; in other specimens, e.g. A. 10284, it has indentations coinciding with the longitudinal furrows.

Dimensions.

	Length	Width	
		Minimum	Maximum
A. 10222	13 mm	2·0 mm	2·5 mm
A. 8854	10 mm	3·0 mm	4·0 mm
A. 10129	22 mm	2·5 mm	3·0 mm
A. 10284	6 mm	2·0 mm	2·5 mm

Remarks. The obscure external ornamentation of these tubes can be attributed to a large extent to their weathered condition. Lacking the well-defined nodosity characteristic of *Genicularia* (*Glandifera*) Regenhardt, they have an outline quite similar to species of *Ditrupa* (*Tetraditrupa*) Regenhardt. However, they are more closely comparable with *G.* (*Glandifera*) *vultuosa* Regenhardt from the Aptian of Germany and tubes from the Cenomanian of Dover, Kent, and Hunstanton, Norfolk, and the Gault Clay of Folkestone, Kent, provisionally referred to *G.* (*Glandifera*) *rustica* (J. de C. Sowerby). Both of these species have stronger nodose swellings than *G.* (*Glandifera*) *inornata* and in the latter the longitudinal furrows are narrower and deeper.

Subfamily FILOGRANINAE Rioja, 1923
Genus GLOMERULA Nielsen, 1931
Glomerula gordialis (Schlotheim)

Plate 20, fig. 5

1820 *Serpulites gordialis* Schlotheim, p. 96.
1831 *Serpula gordialis* Goldfuss, p. 234, pl. 60, fig. 8.
1854 *Serpula gordialis* Sharpe, p. 193.
1883 *Serpula gordialis* Keeping, p. 132.
1931 *Glomerula gordialis* Nielsen, p. 88, pl. 1, figs. 9–10.
1961 *Glomerula gordialis* Regenhardt, p. 26, pl. 1, fig. 2.
1964 *Glomerula gordialis* Muller, p. 620, text-figs. 5–6.
1967 *Glomerula gordialis* Pugaczewska, p. 180, pl. 1, figs. 5–10.
1968 *Glomerula gordialis* Bignot, p. 18, pl. 1, fig. 1; pl. 2, figs. 1–4.

Material. 108 specimens mainly from Faringdon, Oxfordshire.

Distribution (Aptian). Sponge Gravel, Faringdon, Oxfordshire; Lower Greensand, Upware, Cambridgeshire and Brickhill, Buckinghamshire; Hythe Beds, Hythe and Broughton Mount, Kent; Ferruginous Sands, Crackers, Blackgang Chine, Shanklin, Isle of Wight; Atherfield Clay (*Perna* Bed), Atherfield, Isle of Wight.

Diagnosis. Tube smooth, undulating; initial stage attached, subcylindrical, coiled; adult stage free, cylindrical, trochospiral or contorted. Diameter of tube: 0·5 mm–2·0 mm.

Remarks. The development of *Glomerula gordialis* (Schlotheim) from a fixed, initially coiled stage to one in which the free adult tube is at first straight and finally spiral or contorted was described by Müller (1964). This concept of the species has since been adopted by Pugaczewska (1967) and Bignot (1968) for Upper Cretaceous tubes from Boryszew, Poland, and the Dieppe region of France.

A collection comprising seventy-four specimens of this species obtained from the Sponge Gravel at Faringdon includes free spiral and contorted tubes and attached coiled initial tubes (Pl. 20, fig. 5) as envisaged by Müller (1964). In diameter the attached tubes have a maximum of 0·5 mm and the free tubes 2·0 mm. The attached tubes occur on shells of various types and phosphatic nodules but mainly on Calcareous sponges, especially *Raphidonema*. In some cases the tube itself is encrusted by bryozoa.

Genus SARCINELLA Regenhardt, 1961
Sarcinella plexus (J. de C. Sowerby)

Plate 20, fig. 6

1829 *Serpula plexus* J. de C. Sowerby, p. 201, pl. 598, fig. 1.
1831 *Serpula socialis* Goldfuss, p. 235, pl. 69, fig. 12.
1836 *Serpula filiformis* Sowerby *in* Fitton, p. 346, pl. 16, fig. 2.
1961 *Sarcinella sarcinella* Regenhardt, p. 29, pl. 1, fig. 6.
1961 *Sarcinella socialis* Regenhardt, p. 29, pl. 1, fig. 5.
1968 *Sarcinella plexus* Bignot, p. 19, pl. 1, figs. 2–4.

Material. Eleven specimens in the British Museum (Natural History) collections and six specimens in the Keeping Collection at Sedgwick Museum, Cambridge.

Distribution (Aptian). Lower Greensand, Upware, Cambridgeshire; Bargate Stone, Littleton and Shackleford, SW. of Guildford, Surrey; Hythe Beds, Hythe and Great Chart, Kent, and Sevenoaks, Kent, and Godstone, Surrey; Folkestone and Sandgate Beds, Folkestone, Kent; Ferruginous Sands, Crackers, Shanklin, Isle of Wight; Atherfield Clay, Atherfield, Isle of Wight.

Emended diagnosis. Smooth, cylindrical tubes occurring in compact, twisted masses or in bunches of slightly curved, more or less parallel tubes. The diameter of the tube which does not vary in individuals ranges from 0·8 mm in slender tubes to *c.* 1·6 mm in the largest ones.

Remarks. Whereas the tubes form twisted masses in *Serpula plexus* J. de C. Sowerby, in *Serpula socialis* Goldfuss, *S. filiformis* J. de C. Sowerby, and *Sarcinella sarcinella* Regenhardt the individual tubes forming the aggregate are almost parallel to each other. No significant difference apart from this exists between these species and for this reason the author agrees with Bignot (1964) in placing them in *Sarcinella plexus* (J. de C. Sowerby). As he pointed out, Regenhardt (1961) overlooked this species which has priority over *S. socialis* Goldfuss.

S. plexus is most frequently found in the form of parallel bunches in the British Lower Greensand beds.

Subfamily SPIRORBINAE Chamberlin, 1919
Rotularia polygonalis (J. de C. Sowerby)

Plate 21, figs. 9–10

Material. Thirty specimens in the British Museum (Natural History) collection and five specimens in the Keeping Collection at the Sedgwick Museum, Cambridge.

Distribution (Aptian). Lower Greensand, Upware, Cambridgeshire; Bargate Stone, Shackleford, SW. of Guildford, Surrey; Hythe Beds, Hythe, Seabrooke and Maidstone, Kent; Ferruginous Sands, Crackers and Upper Lobster Bed, Atherfield, Isle of Wight; Atherfield Clay, Sevenoaks, Kent, and Atherfield, Isle of Wight.

Original description. Spiral portion a short cone, with one involute ridge running up to the apex, and two ridges round the margin; produced part trumpet-formed, with seven acute angles.

Remarks. Although this species is generally found in the form of small discoid tubes (Pl. 21, figs. 9–10) with the characteristic trumpet-shaped free portion missing, it is easily recognized by the three ridges which distinguish it from the other species. Most of the tubes are dextrally coiled and in shape they vary from flat discs to slightly conical. The species is fairly common in the Hythe Beds and Atherfield Clay in Kent and the Crackers in the Isle of Wight, but elsewhere it appears to be comparatively rare.

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REFERENCES

ARKELL, W. J. 1947. *The Geology of Oxford*, pp. 1–267, 6 pls., 49 text-figs. Oxford: Clarendon Press.

BIGNOT, G. 1968. Remarques sur quelques serpulidés de la craie de la région de Dieppe (S.-M.). *Bull. Soc. géol. Normandie*, **58**, 17–29, pls. 1–2.

CASEY, R. 1961. The stratigraphical palaeontology of the Lower Greensand. *Palaeontology*, **3**, 487–621, pls. 77–84.

ELLIOTT, G. F. 1947. The development of a British Aptian brachiopod. *Proc. Geol. Ass.* **58**, 144–159, pls. 3–4.

—— 1956. Post-palaeozoic brachiopod ecology: a re-assessment. *Geol. Mag.* **93**, 196–200.

FITTON, W. H. 1836. Observations on some of the strata between the Chalk and the Oxford oolite, in the South-east of England. *Trans. geol. Soc. Lond.* **4**, 103–388, pls. 7–23.

FLEMING, C. A. 1971. A preliminary list of New Zealand fossil polychaetes. *N.Z. J. Geol. Geophys.* **14**, 744–756, 4 figs.

GOLDFUSS, A. 1826–1833. *Petrefacta Germaniae*, **1**, 1–252, 71 pls. Düsseldorf.

GREGORY, J. W. 1895. On a collection of fossils from the Lower Greensand of Great Chart in Kent. *Geol. Mag.* **32**, 97–103.

HOWELL, B. F. 1962. Worms. *In* R. C. MOORE (ed.). *Treatise on Invertebrate Palaeontology*, *Part W*, W144–W177, figs. 85–104. Univ. Kansas Press.

KEEPING, W. 1883. *The fossils and palaeontological affinities of the Neocomian deposits of Upware and Brickhill*, pp. 1–167, 8 pls. Sedgwick Prize Essay for 1879, Cambridge.

MÜLLER, A. H. 1964. Ein weiterer Beitrag zur Serpuliden-Fauna der Oberkreide. *Geologie*, **13**, 617–627, 1 pl., 9 text-figs.

NIELSEN, K. B. 1931. Serpulidae from the Senonian and Danian deposits of Denmark. *Medd. Dansk. geol. Foren. Copenhagen*, **8**, 71–113, pls. 1–3.

PARSCH, K. O. A. 1956. Die Serpuliden-Fauna des sudwestdeutschen Jura. *Palaeontogr.*, Abt. A, **107**, 211–240, pls. 19–21.

PRICE, F. G. H. 1874. On the Lower Greensand and Gault of Folkestone. *Proc. Geol. Ass.* **4**, 135–150.

PUGACZEWSKA, H. 1967. Serpulidae from the Dano-Montian borehole at Boryszew, Poland. *Acta pal. polon.* **18**, 179–189, pls. 1–3.

REGENHARDT, H. 1961. Serpulidae (Polychaeta sedentaria) aus der Kreide Mitteleuropas, ihre ökologische, taxionomische und stratigraphische Bewertung. *Mitt. Geol. Staatsinst. Hamburg*, **30,** 5–115, pls. 1–9.

—— 1964. 'Wurm-' und Serpuliden-Rohren in Geschieben unter Besonderer Berucksichtigung von 'Riffbildungen'. *Lauenburgische Heimat Ratzeburg*, **45,** 57–62.

ROEMER, F. A. 1840. *Die Versteinerungen des Norddeutschen Kreidegebirges*, pp. 1–140, 16 pls. Hannover.

ROWE, A. W. 1903. The zones of the white chalk of the English coast. III, Devon. *Proc. geol. Assoc.* **18,** 1–51, pls. 1–13.

—— 1908. The zones of the white chalk of the English coast. V, The Isle of Wight. Ibid. **20,** 209–339, pls. 8–23.

SCHLOTHEIM, E. F. V. 1820. *Die Petrefactenkunde*, pp. 1–437. Gotha.

SCHMIDT, W. J. 1955. Die tertiären Wurmer Österreichs. *Denksclir. Österr. Akad. Wiss. math.-nat. Kl. Wien*, **109** (7), 1–121, pls. 1–8.

—— 1969. *Catalogus Fossilium Austriae*, **5,** Vermes, pp. 1–56. Wien.

SHARPE, D. 1854. On the age of the fossiliferous sands and gravels of Farringdon and its neighbourhood. *Quart. J. geol. Soc. Lond.* **10,** 176–198, pls. 5–7.

SOWERBY, J. DE C. 1829. *The Mineral Conchology of Great Britain*. Vol. 6. London.

TOPLEY, W. 1875. The geology of the Weald. *Mem. Geol. Surv. Gt Br.*, pp. 1–503.

WADE, B. 1926. The fauna of the Ripley Formation on Coon Creek, Tennessee. *U.S. Geol. Surv. Prof. Pap.* **137,** 1–192, pls. 1–72.

WIESEMANN, G. 1966. Mäanderförmige Röhren von *Glomerula* Nielsen 1931 (Polychaeta sedentaria)—Wuchsformen oder ökologische Konvergenzen? *Mitt. geol. Staatsinst. Hamburg*, **35,** 151–160.

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